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DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
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# THE MINERAL RESOURCES

OF

# HAWAII

EXTRACT FROM THE NINETEENTH ANNUAL REPORT OF THE SURVEY, 1897-98
PART VI—MINERAL RESOURCES OF THE UNITED STATES, CALENDAR YEAR 1897: DAVID T. DAY, CHIEF OF DIVISION OF MINERAL RESOURCES

WASHINGTON
GOVERNMENT PRINTING OFFICE
1898

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The recent acquisition of the Hawaiian (also called Sandwich) Islands, causing them to become an integral part of the United States, lends renewed interest to this remarkable group, and renders appropriate a brief account of their minerals and certain features bearing upon this phase of their resources. As introductory to this a few general observations are appropriate.

*History.*—Although known and visited by the earlier navigators since their discovery in 1549 by the Spaniards under Gaetano, the Hawaiian Islands attracted little attention from the outside world until more carefully examined and reported upon by Captain Cook in his memorable visits of 1778 and 1779. This great navigator was much impressed by their importance, and his reports awakened attention, but not until the advent of the American missionaries in 1820 and subsequently did the wonderful fertility and possibilities of these islands begin to be fully recognized. Even then there was little development, because there was practically no outside market for their products and the local requirements were so simple and limited, while occasional visits of traders and whalers gave little stimulus. But with the settling and rapid development of the Pacific coast of the United States an outlet for the exportation of tropical fruits, etc., and later of sugar, was opened, and from that time on progress has been marked and constant.

American influence has predominated during the last seventy or eighty years, though English and other settlers were also present and helped to effect the change in the habits, pursuits, and condition of the aboriginal inhabitants. When first known to Europeans the islands were under a sort of feudal and hieratic system or systems, which were consolidated into a single monarchy by the conquests of Kamehameha I. Later the Government became a liberal, limited monarchy, with a constitution, and having in part a representative character. This was overthrown by the revolution of 1892. During the Administration of President Harrison a treaty annexing the islands to the United States was negotiated, but it was withdrawn by President Cleveland. On June 15, 1898, the Newlands joint resolution of annexation was passed by the House of Representatives, and by the Senate July 6 following. The signature by President McKinley, July 7, and the formal raising of the American flag in August, completed the annexation.

*Geography.*—The Hawaiian Islands are in latitude 18° 51′ to 22° 50′ N., and longitude 154° 50′ to 161° 40′ W., and are about 2,700 miles southwest of San Francisco. There are twelve islands in the group, of which nine are inhabited, and three are barren rocks. The total area is 6,677 square miles. Hawaii proper, the largest island, contains about 4,000 square miles. Oahu is the most important commercially, having the fine harbor of Honolulu and Pearl Harbor. The other principal islands are Maui, Molokai, and Kaui.

The interior of the larger islands is mountainous, with elevations ranging up to the 13,805 feet of Mauna Kea, on Hawaii. There are fertile valleys and plateaus of varying elevation, rainfall, and temperature, and the lowlands bordering the ocean.

*Population.*—The estimate of 400,000 inhabitants given by Captain Cook a century ago was doubtless excessive. In 1820 there were supposed to be about 130,000 natives, since which time they have been steadily diminishing. Originally a fine, strong, brave, but too docile and hospitable a race, they have succumbed to the mistaken efforts of their well-meaning civilizers, the natural result of radical and sudden changes of diet, clothing, habits, etc., upon a physique evolved during ages of adjustment to environment; while the diseases and vices introduced by traders and sailors have had a further deteriorating effect, so that in 1890 only 34,436 of the native stock remained, the fact that the native Hawaiians are still dying off being indicated by the decrease of 5,578 between 1884 and 1890. In the latter year the total population was 89,990; it is now larger, immigration having more than offset native losses. There were 15,301 Chinese and 12,369 Japanese on the islands in 1890, which numbers have been increased. No fewer than 15,191 Portuguese had arrived in the islands by 1895, nearly all of whom were "assisted" immigrants from the Azores. At present there are some 7,000 Americans, British, Germans, and Norwegians there, of whom about 2,200 are of island birth, and somewhat over 2,000 were born in the United States. It is expected that the number of Americans and of desirable European settlers will be considerably increased by immigration. It is also anticipated that the material prosperity of the islands will still further improve under the new and stable control.

*Agriculture in relation to minerals.*—The agricultural capacity of the islands far overshadows the mineral, strictly speaking. Yet it is owing to the peculiar mineral constituents of the soils, together with the stored accumulations of organic matter and in connection with a favoring climate as regards temperature, sunlight, dryness or humidity, and distribution of rainfall, that the adaptability to certain crops, especially the sugar cane, coffee, tropical and semitropical fruits, vegetables, and nuts must be ascribed. The mineral resources of first importance are therefore the soils, as the basis for agricultural prosperity.

Since thus far attention has mainly and naturally been directed toward the development of agriculture, the efforts and opportunities to utilize and exploit the mineral resources other than the soils themselves have been comparatively slight. Nor is it to be anticipated that the useful mineral products will be of great importance relatively, being limited, both in kind and in quantity. The actual number of mineral species identified is quite large, corresponding to those of similar volcanic areas, but most of them are mineralogical specimens merely, rather than available for commercial purposes. Still, it must not be understood that the mineral wealth of Hawaii is wholly insignificant. On the contrary, there is an apparent field for a considerable development. The scientific study of the group has mostly been turned toward the physical geography, phenomena of vulcanism, coral growth, and latterly the chemical examination of the soils, the mineralogical interest being subsidiary.

*Geology.*—The core and mass of the islands consists of volcanic rocks built up from the ocean floor in comparatively recent geologic times, though at long intervals, as measured by years or centuries. These rocks range from basalt to trachyte, forming a complete series, from the most basic to the acidic, but consisting almost wholly of the more basic members, acidic rocks being much less occurrent. The proportion of the basic rocks is so large that one authority says: "Our lavas are strictly basalts." The two main classes of phonolites and graystones are, however, recognized with the usual intermediate species, varieties, and shades of gradation. Part of the rock masses are quite fresh, part much altered by chemical action and weathering. As the volcanoes, ancient and extinct to the recent and active Kilauea and Mauna Loa, all rise from the deep-sea bottom to in some cases great elevations above the sea surface, they are the most notable examples in point of magnitude and existing interest known. The craters are of both the primary and the lateral-cone types, and some of the older ones are not now recognizable, owing to weathering, denudation, and filling. Parts of ancient empty volcano throats have been exposed by caving.

Besides the predominating basalt of the eruptive rocks there are heavy fringing and barrier coral reefs, some of which have been elevated far above sea level, and in disintegrating and then compacting a calcareous sandstone has been formed, in addition to the coral limestone of the reefs in place. There are no true fossiliferous strata, but fossil shells and corals of recent species are found embedded in some of the volcanic tufas.

*Mineralogy.*—According to Mr. S. B. Dole some of the minerals noticed are sulphur, pyrite, common salt, sal ammoniac, limonite, quartz, augite, chrysolite, garnet, labradorite, feldspar, gypsum, soda-alum, copperas, glauber salt (sodium sulphate), niter, and calcite. The Hawaiian volcanoes have been natural laboratories, working on an almost unprecedented scale, with the strong decomposing agency of acid steam, high

temperature, rainfall, and perhaps sea infiltration, so that secondary decomposition products are numerous and common. Many of the minerals identified have no economic significance, while others occur too sparsely to be profitably utilized. As at other volcanic localities and island resorts much frequented by travelers and health seekers, there is a considerable trade in specimens and curiosities of the two extreme types of products, the volcanic and the marine. These consist in minerals and fantastic lava forms from the craters and corals and shells from the shores and sea.

The geological conditions are against the occurrence of deposits of ores of the precious and other heavy metals, and, of course, preclude the formation of coal beds.

*Soils.*—These are derived from the volcanic lavas. According to Prof. Walter Maxwell, director and chief chemist of the Hawaiian experiment station,[1] the lavas are (1) those which have been discharged from craters, flowing and cooling into rocks having the composition of normal basalts. Others (2), originally of the same composition, have undergone such alteration that they now compose masses having a radically different composition and color. Professor Maxwell's classification is as follows:

1. Dark-red soils, formed by the simple weathering of normal lavas, in climatic conditions of great heat and dryness.

2. Yellow and light-red soils, derived from lavas which underwent great alteration, under the action of steam and sulphurous vapors, at the time of or after emission from the craters.

3. Sedimentary soils, derived from the decomposition of lavas at higher altitudes, and removal and deposition by rainfall at lower levels.

The color is an indication of the amount and condition of the iron present, and is also affected by carbonaceous matters. In general, the dark-red and sedimentary soils are distinguished by a greater and more permanent fertility than the yellow or light-red soils.

*Sulphur.*—The craters and upper slopes of the volcanoes are, or have been, vast solfataras, of which that of Kilauea is now the most notable. Numberless fumaroles or pipes and fissures of varying size extend from the heated interior to the surface, affording vents for sulphurous vapors. About them the surface is white with deposits of sulphur, and upon their sides and in places below the surface masses of the pure mineral are crystallized out. The quantity is so marked that one locality at Kilauea is known as the "sulphur banks," though this is but one of many remarkable occurrences.

Pyrite occurs as a secondary rock constituent, but not in segregated masses or veins in sufficient quantity to form a basis for acid making.

The water condensed from the steam and vapors of the fumaroles is charged with sulphuric acid, samples running as high as 5 per cent. It is not altogether inconceivable that some utilization might in future be

[1] Lavas and Soils of the Hawaiian Islands, 1898.

discovered for the immense quantity of mineral acid constantly escaping in this dilute form.

*Gypsum.*—Very large deposits of this mineral occur, some of it almost pure, as shown by the following partial analysis: CaO, 43.4 per cent; $SO_3$, 44.73 per cent; $SiO_2$, 4 per cent; $Fe_2O_3$, 0.7 per cent; MgO, 0.5 per cent. This is another substance which might be utilized, as land plaster if not as plaster of paris, though the small content of iron in the analysis just quoted (from Professor Maxwell) shows it to be suitable for making a very clean plaster of paris.

*Alum.*—The mineral of the so-called alum deposits is a mixture of the sulphates of the alkalies, iron, and alumina, with an excess of sulphuric acid. A sample analyzed as follows: $Al_2O_3$, 26.2 per cent; $Fe_2O_3$, 12.3 per cent; $SO_3$, 45.6 per cent, with small quantities of CaO, MgO, $K_2O$, $Na_2O$, and $SiO_2$. This occurs in large quantity and could be purified for commercial use.

*Copperas* (iron sulphate) is formed by the action of sulphurous vapors and waters upon the ferruginous basalts. It is only of mineralogical interest in this connection.

*Glauber salt* is similarly produced, probably from the soda liberated in the decomposition of the soda feldspars of the rocks; hardly from the salt of sea water, since free chlorine is not detected.

*Sal-ammoniac* (ammonium chloride) occurs as an efflorescence.

*Mineral paints.*—Red ocher (hematite and laterite) and yellow ocher (limonite) of vivid hues are abundant, as is also brown hematite. These are decomposition products derived by oxidation from the iron of the volcanic rocks, and are found in large pockets and in layers covering the surface of altered rock masses and along the jointing planes of the blocks. A sample of red ocher gave $Fe_2O_3$, 44.5 per cent; $SiO_2$, 32.5 per cent; $Al_2O_3$, 18.1 per cent, with moisture and small percentages of CaO, MgO, $K_2O$, $Na_2O$, and S. The yellow ocher consists in large proportion of silica; when burned it becomes pink or red. The quantity available and the good color of these ochers are such that attempts have been made to establish an export trade in them, but manufacturers of mineral paints in the United States are influenced by the accessibility of similar ochers nearer points of consumption. Their excellence and the results to be obtained by proper selection, grinding, burning, or mixing to produce different shades, should lead to further experiment to obtain for them something more than a restricted local utilization.

Some of the kaolinized rock, from which the iron has been leached out, forms a white clay, which might be used, as in other localities, for whitewashing, for which purpose a natural free lime, also an alteration product, is also obtainable.

*Building stone, etc.*—The climatic conditions and mode of life of the inhabitants do not call for much construction in stone, though there is an abundance of available material, only a little of which is utilized.

The coral limestone, calcareous and siliceous sandstones, primary eruptive rocks of fair cleavage and tufa afford a considerable variety from which to choose, but wooden construction is more common. Road material, stone for fences, jetties, fillings, etc., are also at hand. All these, together with the excellent clays for brick and tile making, lime and building sand, have but local application. The lime is obtainable by burning the coral limestone and shells.

*Kaolin.*—Pockets of large size and sometimes very pure material have been found. This mineral results from the decomposition of the rock-constituent minerals, especially feldspars, the silica and alumina separated out being recombined. The scale upon which the rock alteration has gone on warrants the assumption that workable deposits of kaolin may be numerous.

*Pumice.*—The froth and scoriæ at the surface of cooling lava flows yield a sort of pumice, serviceable either as a powder after crushing or when broken into blocks of convenient size. The filaments blown by the winds from the surface of molten lava, called "Pele's hair," are interesting specimens, corresponding in mode of formation to the artificial mineral wool produced by steam jets acting upon iron slag, which itself is analogous to lava.

*Obsidian* (volcanic glass) is noted merely as a curiosity.

*Salt.*—An industry of some local importance is the gathering of sea salt from accumulations formed by the natural concentration and evaporation of sea water, while the configuration of the shores in places, with suitable inlets and lagoons, aided by the strong solar evaporation, favors the artificial production of this commodity.

*Nacre*, or mother-of-pearl, occurs, and with other ornamental shells and corals forms pretty specimens.

*Pearls* have been found, but a productive industry of commercial importance remains to be established.

In conclusion, it may be said that the most important and promising mineral products of the Hawaiian Islands are the sulphur, gypsum, alum, mineral-paint ochers, all of which occur in large quantities and of good quality, and common salt, which latter is producible according to the demand. Besides these, some of the other substances already noted or yet to be found may come into commerce to an extent not now understood. At least there is much encouragement for further exploration and experiment in the finding, working, preparing, and marketing of the useful minerals of Hawaii.